# Initial report on digitally researching the network drawings of Mark Lombardi

Robert Tolksdorf

Networked Information Systems
Institute for Computer Science
Freie Universität Berlin
Berlin, Germany
E-mail: tolk@ag-nbi.de.

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## Abstract

*We do digital research on the artist Mark Lombardi (1951-2000) as an experiment in methods for digital art history. We manually generate GraphML representations of the networks depicted in his drawings and publish them at http://www.lombardinetworks.net. Services on the data are implemented like textual search on labels of nodes or an index on what persons or institutions appear in which works.*

*We visualize the networks with nodes linked to Wikipedia information about the actors. With calculations on the networks we generate synthetic drawings from multiple original works that overlap in actors.*

We conduct digital studies on the drawings of the US-american artist Mark Lombardi (1951-2000) which depict networks of actors involved in various scandals on money laundering and weapon deals like the Iran-Contra affair.

To discover the knowledge contained in the drawings, Lombardi started with extensive research into publicly accessible sources on such affairs. He took notes on the relations amongst persons and institutions involved on index cards. From these, he started with initial sketches of networks which then were developed over several versions into pencil on paper drawings.

Nodes in the networks are persons or institutions and the edges represent a small number of vague relations such as “association”, “influence” or “financial transaction” and come in about 5-6 different graphic notations.

The works contain knowledge about the scandals depicted. Lombardi called them “narrative structures” since following the graphical paths in the networks tell a story of who was involved with whom to undertake specific transactions. The aesthetical value of the works stems from the way the networks are layouted.

Lombardi is well received, for example, he was exhibited at dOCUMENTA (13). Most recently, a documentary contains valuable insights into his life and work [1].

From a computer science perspective one can understand a drawing as a datastructure representing a network. Nodes and edges are typed and carry labels. As a contribution to digital art history we started a project which addresses two basic layers for digital research into the works of Lombardi:

- Make digital representations of the works in standardized dataformats publicly available.
- Provide services on the digital representations that contribute to research on them.

Our project is an experiment in methods for digital art history that also offers new insights into the specific network drawings of Mark Lombardi.

## Digitization of the Drawings

Digitization of the drawings as datastructures and not as pictures requires a specific process. We have developed a very small datamodel in which nodes and edges are typed according to a simple typology as found in the works. It is represented as an ontology based on the Web standard OWL [2].

We then work as followings:

1. We use scans or photographs of the original drawings and manually record all relations found. Figure 1 shows how we manually mark relations that are digitized. As a tool we use a simple spreadsheet that helps us with autocompleting the URLs of the edge types defined in our ontology.

For each relation we use the labels from the drawings as node-identifiers. If existent, we also record labels found at the edges in the drawings.

2. This simple representation is imported into the Cytoscape tool to type nodes. Cytoscape also analyzes the resulting network and adds some standard network metrics.
3. Finally we export the network in the GraphML [4] format and publish it on the net at http://www.lombardinetworks.net.

We measured the speed of the process with the examples that we did. Recording the relations and typing the edges takes about 30 minutes for 40 relations. In 10 additional minutes about 35 nodes can be typed. If we assume a certain density of the drawing based on its size, we can estimate that the famous Lombardi work *BCCI, ICIC & FAB, 1996–2000* with its size of 132 × 353cm can be digitized within about 75 hours of work.

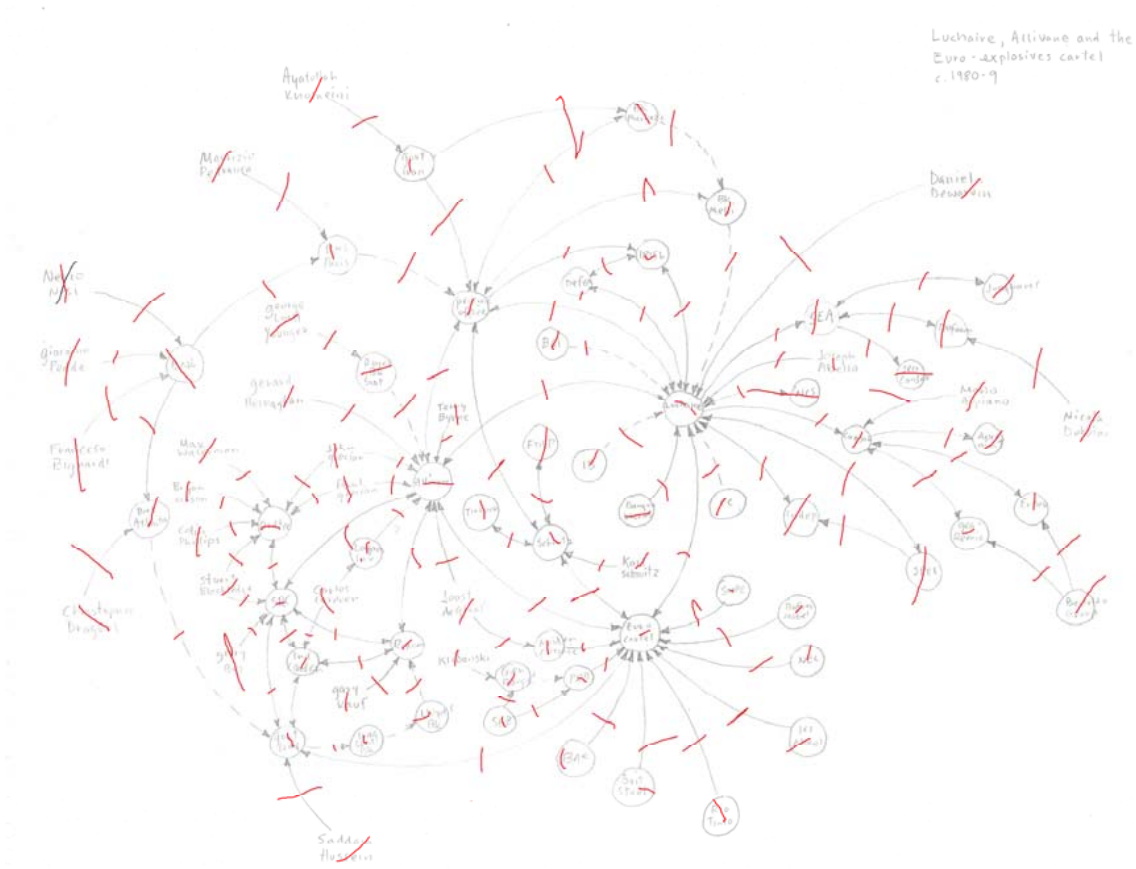

**Fig 1: A scan after manual digitization**

The networks can be downloaded or used otherwise under the Creative Commons Attribution-ShareAlike 3.0 Unported License. While we digitize each work as a complete network, each node and edge is provided with a unique identifier. Together with the URL of the network file this means that every specific single artifact in the drawings can be addressed with a URI. This allows it to add further information, for example if the same person is named differently in different works.

**Initial services**

The networks provided are public and free to use. Their value is exhibited when used in services that help to explore the work of Lombardi further. We have set up an initial set of services to give an impression. The first services help to get an overview on the persons and institutions occurring in the drawings:

- Since the drawings digitally represented with the labels used as strings, we implement a search on the drawings using a Google custom search limited to the GraphML files. By that we can do searches for specific actors in the drawings with links to the representation of the drawings as the result list.
- We also prepare an index of actors in the narrations. A script collects all names from all drawings

Aside from searching, exploration is the second path to research on the drawings. As a first step, we visualize the networks as such, using available libraries such as d3js [5]. The goal of this is not the imitation of the drawings but resembling them in order to keep researchers familiar with the works oriented.

While the visualization itself does not necessarily add value to the data, we use it as the basis of an interactive information system on the works. We currently connect each node to Wikipedia. More specifically, we take the node label as a search term and link to the respective result page when one clicks on a node in the drawing.

An interesting observation is that the knowledge contained in Wikipedia includes associations in a similar way as Lombardi does. When Wikipedia does not find an exact match for the search it offers several possible related answers. In several cases these lists contain multiple actors that appear together in one drawing.

Finally, we experimented with calculations on the networks. Union and difference of networks are built-ins of the Cytoscape tool. We took two networks from the drawing that overlap in nodes and generated the union.

By visualizing this network, we generated a synthetic drawing from two original works that overlap in two actors. Figure 2 shows the result.

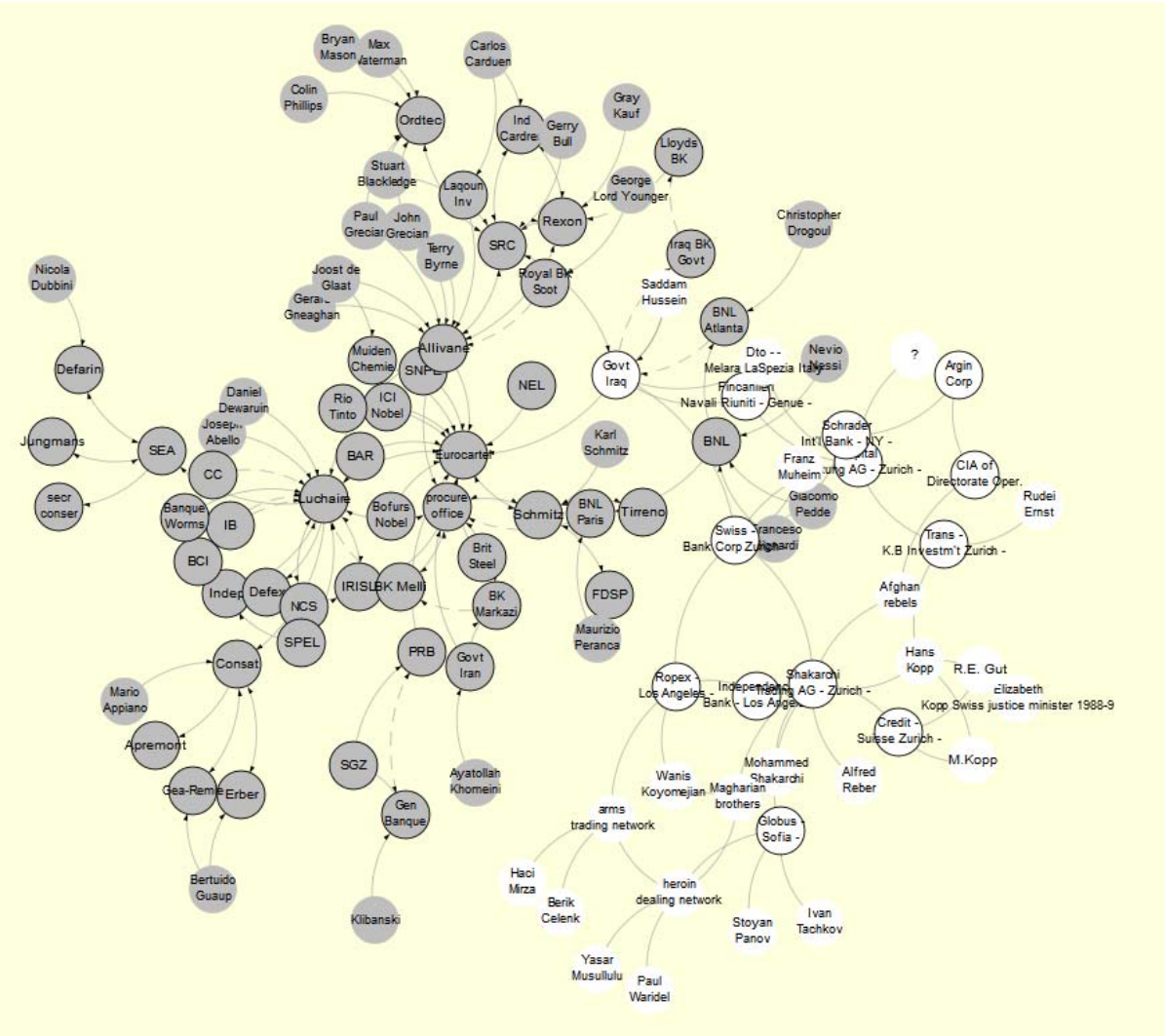


**Fig 2: A synthetic drawing generated from two works (denoted with grey and white)**

Calculating the difference between two networks is of high interest when researching the different versions of the drawings. Lombardi worked on different layouts over time but also added information he ran across between the drawings of two versions. Calculating the difference would systematically highlight what the changes actual are and might lead to more insights into the genesis of the works

**Roadmap**

Our project on Lombardi has the long-term goal of providing complete digital information on Lombardis works. The following results are aimed at:

1. Complete digital representations of all Lombardi works in all versions with a normalization of actors names. A path for this would be to contact all private and public collectors via gallery owners and to have them provide scans or photographs of the works or allow their generation.
2. A scan of all ~14000 index cards from the MOMA archive. These could in turn be made processable via OCR software trained to Lombardis handwriting. The texts then could be analyzed using heuristics specific to Lombardi's way of taking notes and referring to public sources.
3. A processable corpus of all public information that Lombardi used. This is a library of his books in digital form. From the references in the index cards, one would need digital representations of the texts used, eg. via Google books. In turn, the text could be analyzed and linked with the index cards.
4. A processable corpus of all texts written on Lombardi. These include, for example, descriptions of his works by art historians. The corpus could be collected from public Web-sites. It could then be linked with the other information sources to form a huge specialized information system.

All data and services are available at http://www.lombardinetworks.net.

**References and Notes**

**1.** Mareike Wegener. *Mark Lombardi: Death-Defying Acts of Art and Conspiracy*. (2011), film.

**2**. *OWL 2 Web Ontology Language: Primer (Second Edition)* Pascal Hitzler, Markus Krötzsch, Bijan Parsia, Peter F. Patel-Schneider, Sebastian Rudolph, eds. W3C Recommendation, http://www.w3.org/TR/owl2-primer/.

**3**. Shannon P, Markiel A, Ozier O, Baliga NS, Wang JT, Ramage D, Amin N, Schwikowski B, Ideker T., "Cytoscape: a software environment for integrated models of biomolecular interaction networks." *Genome Research* **13** No. 11 (November 2003) pp. 2498-2504.

**4**. GraphML Specification (2009), <http://graphml.graphdrawing.org/specification.html>, accessed 30 May 2013

**5**. Data-Driven Documents (2012), <http://d3js.org/>, accessed 30 May 2013